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Hyperconnected Urban Synchromodality: Synergies between Freight and People Mobility

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Abstract: *This paper investigates the opportunity to exploit an on-demand freight transshipment service in urban areas. This contribution attempts at first to focus on the feasibility to connect people and freight mobility with a joint usage of transportation options. It builds on the hyperconnectivity principles enabled by the Physical Internet (PI) manifesto for city logistics. To this end, this paper proposes an effective solution approach for optimizing multimodal on-demand transshipment. The approach considers multiple mobility options such as on-demand delivery services, cargo bikes, tramways, and buses to transship goods from an urban logistic hub to another. The hyperconnected synchromodal mobility solution is proposed as an alternative option to classical pickup and delivery-based transportation. The proposal is first characterized in link with the interconnectivity needs and then its operability is modeled as a new transportation approach. The proposed solution aims to increase the sustainability of cities by reducing congestion levels, the impact of logistics moves, as well as carbon emissions in urban areas. An illustrative case is provided to demonstrate how the novel hyperconnected synchromodal transportation system could operate, and to provide an evaluation of the economic and sustainability benefits of such system in an urban context.*

Keywords: *Hyperconnected City Logistics, Synchromodality, Physical Internet, Parcel Distribution, Sustainable Mobility*

Conference Topics: *Distributed intelligence, last mile & city logistics.*

Physical Internet Roadmap *(Link): Select the most relevant area for your paper: ☐ PI Nodes, ☐ PI Networks, ☒ System of Logistics Networks, ☐ Access and Adoption, ☐ Governance.*

1 Introduction

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2 Literature review

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3 Multimodal on-demand transshipment problem

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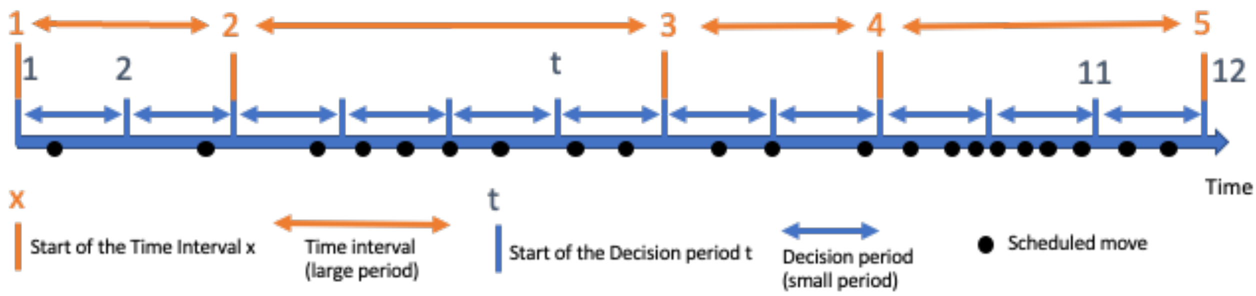

Figure 1: Time settings

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Figure 2: Multimodal good transportation system within Physical Internet context

4 Illustrative example

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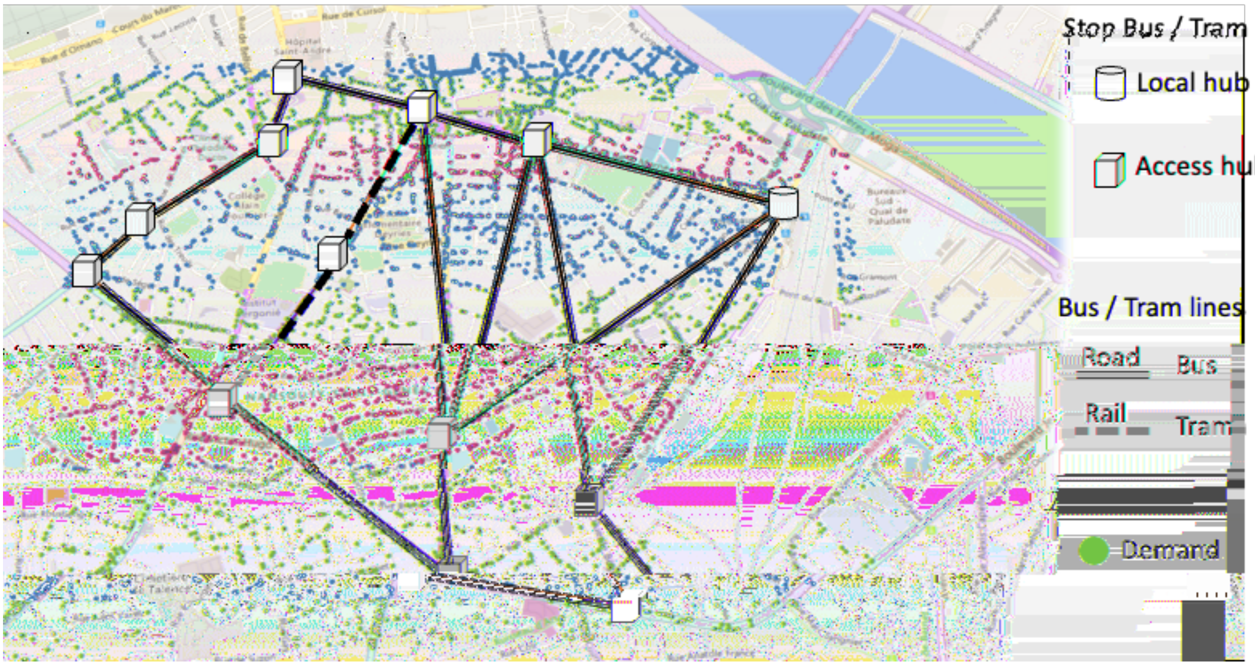

Figure 3: Spatial pattern of freight movements in Bordeaux hypercentre (one week)

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5 Preliminary results

5.1 Scheduled multimodal delivery service

	Period		
	1	2	3
1	6:00		
2	6:12		
3	6:30		
4	6:42		
5	7:00		
6		7:12	
7		7:30	
8		7:42	
9		7:48	
10		7:54	
11			8:12
12			8:30
13			8:42
14			8:54

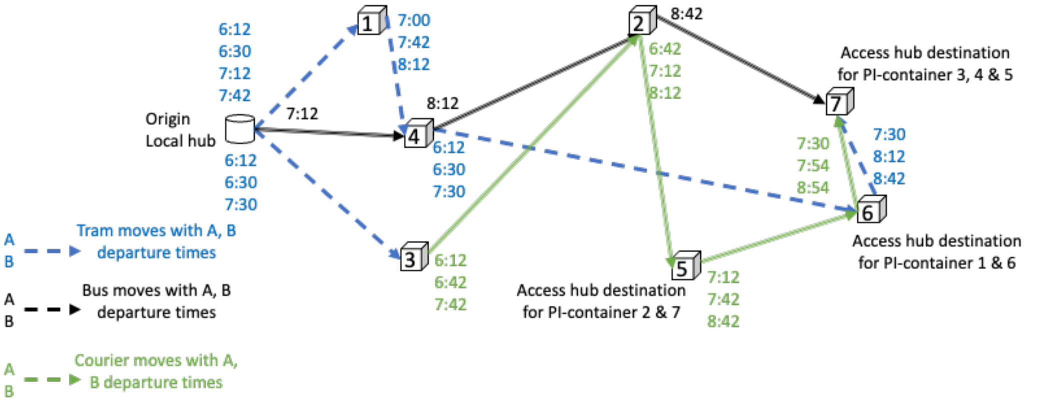
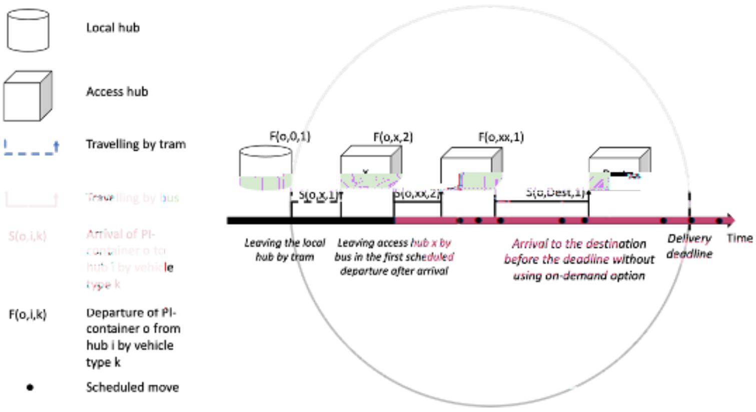


Figure 4: Timetables and multimodal network



PI-Container	Access hub destination	Delivery due time	Arrival time to the destination node
1	6	7:00	7:24
2	5	9:00	7:36
3	7	8:00	7:48
4	7	[illegible]	8:00
5	7	[illegible]	9:00
6	6	[illegible]	8:00
7	5	[illegible]	7:00

Figure 5: Example of delivery plan

5.2 Multimodal on-demand delivery service versus routing

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Truck n°1								
					Actual delivery time			
			Due date		Multimodal & on-demand		VRP	
Nb Order	Origin	Destination	min	sec	min	sec	min	sec
1	1	2	119	7140	102,20	6 132	3,28	197
7	1	2	119	7140	102,20	6 132	3,28	197
8	1	2	92	5520	87,20	5 232	3,28	197
16	1	2	75	4500	73,20	4 392	3,28	197
3	1	3	66	3960	62,00	3 720	11,82	709
4	1	4	77	4620	77,00	4 620	21,07	1 264
9	1	4	118	7080	105,80	6 348	21,07	1 264
27	1	4	110	6600	103,00	6 180	21,07	1 264
12	1	5	74	4440	73,20	4 392	29,80	1 788
13	1	5	48	2880	45,20	2 712	29,80	1 788
26	1	5	100	6000	99,50	5 970	29,80	1 788
5	1	9	42	2520	40,20	2 412	71,00	4 260
6	1	9	71	4260	70,50	4 230	71,00	4 260
11	1	9	56	3360	54,20	3 252	71,00	4 260
19	1	8	80	4800	76,50	4 590	80,02	4 801
20	1	8	76	4560	67,50	4 050	80,02	4 801
30	1	8	105	6300	86,50	5 190	80,02	4 801

Truck n°2								
					Actual delivery time			
			Due date		Multimodal & on-demand		VRP	
Nb Order	Origin	Destination	min	sec	min	sec	min	sec
17	1	12	83	4980	69,80	4 188	4,58	275
21	1	12	92	5520	89,00	5 340	4,58	275
23	1	12	55	3300	43,20	2 592	4,58	275
14	1	10	64	3840	62,80	3 768	41,80	2 508
28	1	11	97	5820	96,00	5 760	50,05	3 003
15	1	13	87	5220	83,00	4 980	59,83	3 590
18	1	13	71	4260	69,00	4 140	59,83	3 590
25	1	13	88	5280	83,00	4 980	59,83	3 590
29	1	13	105	6300	98,00	5 880	59,83	3 590
2	1	7	54	3240	52,20	3 132	69,37	4 162
24	1	7	86	5160	80,80	4 848	69,37	4 162
10	1	6	78	4680	77,20	4 632	78,00	4 680
22	1	6	76	4560	63,50	3 810	78,00	4 680

Figure 6: Deliveries plans of 30 PI-containers (Multimodal & on-demand versus VRP)

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6 Conclusion

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